ABSTRACT

The present invention relates to metrologic methodologies and instrumentation, in particular laser-frequency domain infrared photocarrier radiometry (PCR), for contamination and defect mapping and measuring electronic properties in industrial Si wafers, devices and other semiconducting materials. In particular the invention relates to the measurement of carrier recombination lifetime, τ, carrier diffusivity, D, surface recombination velocities, S, carrier diffusion lengths, L, and carrier mobility, μ, as well as heavy metal contamination mapping, ion implantation mapping over a wide range of dose and energy, and determination of the concentration of mobile impurities in SiO_2 layers on semiconductor substrates. The present invention provides a method and complete photocarrier radiometric apparatus comprising novel signal generation and analysis techniques (carrier-wave interferometry) as well as novel instrumental hardware configurations based on the physical principle of photocarrier radiometry. The method comprises (a) optical excitation of the sample with a modulated optical excitation source and (b) detection of the recombination-induced infrared emission while filtering any Planck-mediated emissions. The present invention provides an instrumental method for detecting weak inhomogeneities among semiconducting materials that are not possible to detect with conventional single-ended photocarrier radiometry. The method comprises (a) irradiating both sides of the sample with modulated optical excitation sources that are 180 degrees out of phase with respect to one another and (b) monitoring the diffusion of the interfering, separately generated carrier waves through the corresponding recombination-induced IR emissions for PCR detection, or the use of an alternative detection scheme that monitors a sample property dependent on the carrier wave transport in the sample.